INDIAN TEA ASSOCIATION.

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT 1948.

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13 JUN 1950

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1 CHIEF SCIENTIFIC OFFICER'S REPORT

1. Staff.

At the beginning of the year the senior staff at Tocklai consisted of :—

Mr. C. J. Harrison	...	Chief Scientific Officer
Mr. A. C. Tunstall	...	Mycologist
Dr. W. Wight	...	Botanist
Mr. N. M. Macgregor	...	Senior Advisory Officer
Mr. E. J. Winter	...	Advisory Officer, Surma Valley
Mr. E. Hainsworth	...	Pathologist
Mr. N. G. Gokhale	...	Soil and Analytical Chemist
Dr. E. A. H. Roberts	...	Bio-chemist
Mr. R. I. Macalpine	...	Advisory Officer, Darjeeling and Terai.
Mr. P. M. Glover	...	Advisory Officer, Assam Valley and North Bank
Dr. G. M. Das	...	Entomologist
Mr. S. K. Dutta	...	Agriculturist

The Station suffered the loss by resignation and retirement, of three of its senior Officers. Dr. E. K. Woodford (Agriculturist) left in January, Mr. N. M. Macgregor (Senior Advisory Officer) and Mr. A. C. Tunstall (Mycologist) in March.

Mr. R. I. Macalpine (Advisory Officer, Darjeeling and Terai) and Mr. P. M. Glover (Advisory Officer, Assam Valley & North Bank) joined the Department in June.

Dr. W. Wight proceeded on home leave on the 5th June and returned to Tocklai on the 17th September, having visited the Botanical Gardens, Calcutta before returning to Tocklai.

2. Building and Equipment.

The following statement gives the position at the end of 1948,

Item.	Building	Progress 1948	Further work required in 1949.
1.	Main Office, Library and Lecture room.	Re-organisation of office completed.	
2.	Chemical Building	—	Minor reconstruction Equipment of Biochemical Dept. *
3.	Botanical Building	—	Of the alterations sanctioned in 1946, windows for the microscope room have yet to be fitted. Structural steel work to be painted with anti-corrosive paint. War time damages to dark room not yet repaired.
4.	Agricultural	—	Minor repairs.
5.	Pathological	Insectary and reconstruction of Mycological Section	Roof to be painted with aluminium paint. Insulated Fibre ceiling to be fitted. Cement floor to be relaid.
6.	Factory and Power House.	Factory and Machinery partly renovated.	New Engine to be installed.
7.	Main Stores Godown	—	Minor repairs.
8.	Guest House	Furnished, sanitary and electric fittings completed - Refurnished.	Servants houses to be repaired.
9.	Dispensary	—	—
10.	Bungalow A	—	To be divided into two separate bachelor quarters.

* When Tea Biochemistry and Manufacture work is in full swing it will require the whole of the Chemistry Building, and a new building will need to be erected to house the Analytical and Soil Branch.

Item.	Building	Progress 1948	Further work required in 1949.
11.	Bungalow B	Repairs completed	Complete re-wiring to be done.
12.	Bungalow 1.	—	Corrugated iron roof dating from 1918 to be replaced.
13.	Bungalow 2.	Repairs incomplete	C. 1. Roof dating from 1918 to be replaced. Electric wiring to be replaced.
14.	Bungalow 3.	Repairs incomplete	C. 1. Roof dating from 1918 to be replaced. Electric wiring to be replaced.
15.	Bungalow 4.	Repairs incomplete	Cement floors damaged by 1942 earthquake to be relaid.
16.	Bungalow 5.	Repairs incomplete	Minor repairs.
17.	Bungalow 6.	Repairs incomplete	Major earthquake damage dating from 1942 and requiring cement and iron work.
18.	Bungalow 7.	—	Garage to be built.
19.	Other building	—	Garage for truck. Assistant's quarters to be rebuilt. Cycle shed to be built. Wood mistries shed to be rebuilt.

20. In addition to the above, line houses need repairing and new quarters are to be built. Owing to inability to obtain building materials at present, much of this work will of necessity be of temporary nature.

3. Visitors.

There were 189 visitors to the Station.

Dr. H. R. Braak (Proefstation Experimental Station—West Java), Dr. J. Lamb (Tea Research Institute of Ceylon), Hon'ble Jag Jivan Ram (Minister of Labour in the Central Government) and Hon'ble Omeo Kumar Das (Labour Minister, Assam), Rao Bahadur B. Viswa Nath, C. I. E., D. Sc., Rai Bahadur J. C. Luthra, I. A. S. (Retd.) and D. Lal (Fruit Technologist) were among those who visited the Station.

4. Health.

No new cases of malaria occurred during the year. Apart from field control, anti-malaria work has been extended to Paludrine prophylaxis and D. D. T. house spray. The same procedure will be continued during the year 1949. The incidence of amoebic dysentery has been unusually high amongst both European and Indian staff. Many of these cases are probably old infections contracted during War Service.

5. Publications.

The following publications were issued during the year

Memorandum No. 3 "Elimination of Foreign Matter in Tea" (Revised Edition)

Tea Protection Series No. 2 "Control of Helopeltis by D. D. T. Spraying—1947".

Proceedings of the Sixth Annual Conference.

Twenty-seven serials of Encyclopaedia of Tea.

Two Memoranda are now in the Press—(i) Hedge Planting of Tea
(ii) Leaf Diseases.

6. Touring.

A list of the tours carried out by the various Officers during the year 1948 is attached.

In addition, various Officers paid visits to local estates (within 50 miles of Tocklai) in connection with Advisory and experimental work.

Touring 1948.

Month	Chief Scientific Officer.	Pathologist	Advisory Officer	Botanist	Agriculturist	Entomologist	Physical Chemist	Bio-Chemist
January	Dooars Terai, Darjeeling and Calcutta	Bishnath	—	—	—	—	—	—
February	Shillong, Sylhet and Cachar	Darrang	—	—	—	Sylhet	—	—
March	Darjeeling and Calcutta	Golaghat and Bishnath	—	—	—	—	—	—
April	—	Panitola	—	—	—	—	—	—
May	Doom Dooma	Darjeeling	—	—	—	—	Nowgong Nazira and Golaghat	—
June	Panitola, Calcutta	Darjeeling	Jorhat District	—	—	—		Jorhat
July	—	Darjeeling	Sylhet and Cachar	HOME LEAVE	—	—	—	—
August	—	South India and Ceylon	Jorhat and Nowgong		Doom Dooma	—	Nazira	—
September	Sylhet Nowgong and Darrang	Golaghat	Sylhet, Nowgong Mangaldai Tezpore		—	Tezpore	Golaghat	Calcutta Mangaldai
October	Sibsagar	Doom Dooma	Nazira, Sonari	Doom Dooma	Dibrugarh	—	Terai, Darjeeling and Nazira	—
November	Calcutta, Delhi East Pakistan	Golaghat and Sibsagar	Moran, Sonari Calcutta	—	—	—		—
December	—	Sibsagar and Golaghat	Jorhat	—	—	—	—	—

II. ADVISORY

SURMA VALLEY.

1. General

Mr. E. J. Winter, Surma Valley Branch Advisory Officer resigned during the year and left for England in August.

It was originally intended that Mr. P. M. Glover who joined Tocklai in June should replace Mr. Winter in the Surma Valley. The Partition of India led to the formation of the Pakistan Tea Association, and the acceptance by this body of the Bungalow at Shamshernagar for its use, together with other complications arising out of partition, made it impracticable for Mr. Glover to be stationed in the Surma Valley. As result, in September 1948 on Mr. Winter's departure, the Surma Valley Advisory Branch was placed temporarily on a maintenance basis, under the charge of Mr. Chakravarty, who was Mr. Winter's assistant.

2. Touring.

Prior to his departure, Mr. Winter visited a large number of gardens both in Sylhet and Cachar districts in connection with Advisory work.

The Chief Scientific Officer visited the Surma Valley in February, September and November, 1948. Mr. P. M. Glover visited a number of Gardens in Sylhet and Cachar with Mr. Winter in June and July 1948 ; and again in September 1948.

3. Publications.

Before Mr. Winter's departure, three series of "Quarterly Observations" were published and circulated to all Surma Valley tea concerns. These contained detailed accounts of the advisory and experimental work in progress, together with observations of a practical nature made during tours.

A number of Standard Recommendations were compiled and published, in which simple information, together with standard recommendations as regards treatment and control, in respect of a large number of the more common pests and diseases of tea are set out. These together with Tocklai Publications and Memoranda will continue to be available to planters at the Advisory Branch Office* at Shamshernagar.

4. Helopeltis (Tea Mosquito)

Favourable reports continue to come in from Managers who have followed our recommendations as to the control of *Helopeltis* by the use of DDT (vide Tea Protection Series No. 2)

It is necessary here to stress the absolute necessity to follow the instructions given most carefuly if really satisfactory results are to be obtained. Particular attention must be paid to thorough spraying which means proper supervision, immediate action to control outbreaks, before they become epidemics, and repetition of spraying as and when necessary.

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* Since Closed.

Plant Protection Series No. 2 describes the method of control in considerable detail. It was originally intended to republish this pamphlet after a year to embody anything new which might arise. In view of the many reports which we have received of success, there is no need for any revision at present.

No authenticated report has been received of any increase in incidence of Red Spider as result of control measures used against *Helopeltis*. Enquiries have been made from many Managers and so far *no* single one has had any such experience. Nevertheless, as the spraying of an area *actually* affected by Red Spider, with DDT *could* increase Red Spider by destroying its natural insect enemies, Managers are advised to maintain an adequate supply of lime sulphur solution as an insurance policy.

5. Red Spider.

The data from Mr. Winter's Questionnaire on Red Spider has now been compiled and has been printed in the form of a Memorandum, together with recommendations as regards control This Memorandum has been circulated to tea concerns in the Surma Valley.

6. Manurial Experiments.

Only one such experiment is in progress in the Surma Valley, at Bhubandar T E., on manuring on bheel soils. Four treatments are under examination NPK high, NPK low, N low, PK low and of course, control.

7. Future of the Surma Valley Branch.

The future of tea research in East Pakistan is at present under the consideration of the Government of Pakistan, and the Pakistan Tea Association.

In the meantime the Surma Valley Advisory Branch* will continue to run on a maintenance basis and will serve both Sylhet and Cachar districts as in the past. Tocklai Publications and Mr. Winter's Standard Recommendations will be available at the Branch Office.

The Laboratory* will continue to carry out soil analysis, pH determination, nitrogen estimations, and other routine analyses for the Planter in order to avoid the considerable delay and danger of loss in transit which would inevitably occur if samples were despatched to Tocklai. Results where necessary, will be forwarded to Tocklai, where they will be examined and suitable recommendation made.

Managers are invited to consult Tocklai on any matters in which they require advice or assistance by letter.

P. M. Glover.
Advisory Officer.
Assam Valley & North Bank.

* Since Closed.

ASSAM VALLEY AND NORTH BANK :

1. General.

As has already been recorded it was the original intention that Mr. P. M. Glover should take over as Advisory Officer Surma Valley Branch, from Mr. Winter. For reasons already given the Surma Valley Branch was placed on a maintenance basis and Mr. Glover took up the post of Advisory Officer Assam Valley and North Bank in August, 1948.

2. Touring.

The Advisory Officer toured the Mangaldai, Dekiajuli and Tezpore districts, 20th September to 2nd October, and Sibsagar, Nazira, Sonari and Moran area October 18th to 3rd November.

Visits were also paid to gardens in the Jorhat district and two gardens in the Nowgong area.

3. Publications.

Three serials No. 33, 40 and 43 of the Tea Encyclopaedia were prepared and issued, the latter two in co-operation with the agricultural department.

A Memorandum on the Hedge Planting of Tea was compiled, and is at present in the press.

Some 100 memoranda were issued in answer to letters or as result of visits to gardens.

4. Lectures.

A lecture on Selection and Vegetative Propagation was given in the Thakurbari Club on 29th October, which was attended by about 30 Planters.

5. Field Experiments : Shade and Manures.

Experiments are in progress in the Assam Valley and in the Dooars on many commercial gardens. The more important of these, concern the interaction of nitrogenous fertilisers and shade or no shade. The effects of P and K, either alone, or in combination with each other and, or, N are also being studied.

The statistical analysis of the figures, which have only recently been received, will take some time to complete. The general conclusion is that the maximum economic dosage of N as sulphate of ammonia under moderate to heavy shade is 80 lbs. per acre.

6. Mechanical Plucking.

The experimental plucking machine ordered in 1947 eventually arrived at Tocklai in December 1948. However, Mr. R. R. Deuchars of Kotalgoorie T. E. offered to co-operate with us in carrying out preliminary trials with his own plucking machines and work was begun in July. The Scientific Department

is most grateful to him, both for his carrying out these trials, and for the great amount of trouble he has taken in running demonstrations for us, more specially during our lecture courses.

Test plots were laid down on four areas of tea at Kotalgoorie T. E. to examine the use of the Tarpen Tea Cropper as against hand plucking.

Unfortunately the machines were not ready for use until the beginning of July, by which time the areas had been under hand plucking since the start of the season, and the first and second flushes had been removed. At the time it was thought that this would not matter, in fact it had been hoped that the machine could be brought into use at any period during the plucking season, in emergency, e. g. to deal with an extra heavy rush of leaf, or during the rice-planting season, or after a holiday.

From this season's experience with non-selective mechanical plucking, it would appear that even first class hand plucking, results in the bush having too uneven a plucking surface for machine work. Thus the leaf obtained from the first round of machine plucking, on bushes previously hand plucked, was very mixed, and full of short stalks and janums, old leaf etc.

To rectify this position, cuts of varying severity were made completely to level off the bushes ; and results differed, as was to be expected, in direct proportion to the severity of the cuts. The losses incurred cannot be attributed to the use of the machine, but to introducing the machines too late in the season. For this reason we are unable to quote figures which accurately portray the position, but some very useful observations have been made.

From these observations it would seem that the most promising results will be obtained by tipping to not more than five inches initially, by hand, bringing the machine into use about the first week of May, and raising the plucking level by $\frac{1}{2}$ inch at each round. By this means one will avoid cutting off the janums which form just above the tipping level and are of course left in selective hand plucking. Much has been learnt this season which will be of great value in our trials next year and which will be run throughout the season, starting in May.

It seems quite possible to expect that when this type of machine is fully developed and conditions are at their best, 20 men, two of whom would be skilled technicians, could replace a plucking force of 250 women.

7. Drainage.

As a result this year of heavy rainfall early in the season and a marked absence of bright sunny periods to dry the soil, gardens whose drainage has been adequate in normal years, have in some districts, suffered from waterlogging and Violet Root Rot.

Clearance of choked drains and other improvements in drainage, where possible, combined with the general fall of the water table in September resulted

in a considerable improvement, and though there have been mortalities a large percentage of bushes have recovered, but not without die back and loss in crop.

Gardens which have had trouble from waterlogging should check their drainage during the cold weather and improve and repair wherever necessary.

8. Cultural methods.

a. Plucking.

On a number of gardens, where a rise in initial plucking level from 6" to 8" has been allowed on weak sections or sections over plucked in the past, a considerable improvement has occurred without loss in crop.

A rise from 6" to 8" in the case of mature healthy tea completely covering the ground, may mean a loss of as much as 2 maunds an acre in the first year. Thereafter the loss gradually and progressively lessens until ultimately a gain is made.

Gardens changing over from 6" to 8" initial plucking measure should do so on weak sections first ; all young replanted tea should be brought on to an 8" measure, as also tea after medium prune. Mature healthy sections should be changed to the longer measure progressively. A preliminary rise to 7" and then to 8" is not recommended as a 1" lift does not give an additional leaf.

b. Slope Pruning.

Gardens with tea on teelas would be well advised to slope prune, more particularly tea on steep teelas. Gardens who have gone in for slope pruning have, in almost all instances, gained in crop, due to the much more efficient plucking made possible.

c. Hedge planting.

The planting of tea in hedges, as opposed to square or triangular planting, has the following important advantages :

(a) The number of bushes per acre can be considerably increased without impeding cultural operations, such as plucking and pruning, as would be the case with tea planted $3' \times 3'$ or $3\frac{1}{2}' \times 3\frac{1}{2}'$. In consequence much quicker ground coverage and an earlier economic yield can be obtained than would be case with tea planted $4' \times 4'$ or $4\frac{1}{2}' \times 4\frac{1}{2}'$. The indications are that higher yields per acre are likely, probably as much as an additional 5 maunds per acre from the mature tea. Earlier ground cover will result in a considerable saving in labour on cultivation. As most of the cultivation of young tea takes place during the heavy flushing months, saving of labour on this account is of considerable importance.

(b) Infilling will only require to be done in the first two or three years after planting. Vacant spaces thereafter will rapidly be filled by adjacent plants at such close spacing.

(c) When mechanisation of pruning and plucking are introduced into the Tea Industry, as is bound to occur in the not too distant future, hedge planting will greatly facilitate the use of machines.

(d) Hedge planting greatly simplifies pest control, and will facilitate the use of power spraying or dusting. This is likely to assume much greater importance as result of research being carried out at Tocklai at the present time on prophylactic winter wash spraying of pruned and "cut back" tea.

(e) On terraces, hedge planting provides the most economical use of available space.

(f) On sloping land, hedge planting is a most satisfactory method of control of soil erosion.

(g) When uprooting and replanting, the loss in crop will be reduced due to the tea having reached an economic yield earlier than it would have with normal spacing. This is of considerable importance to gardens with a large uprooting and replanting programme.

A memorandum has therefore been prepared on the subject, summarising the available information on Hedge Planting, to make the pros and cons of different methods and layouts, together with our ideas on the subject, readily available to Managers who are interested. The arguments for and against such methods and layouts are given, but in many instances firm recommendations cannot be made.

The memorandum is at present in the press and will be available shortly.*

9. Pests and Diseases.

(a) Black Rot.

This disease is one of the most serious diseases of tea. Its prevalence this year has been largely due to the heavy early rain followed by periods in which rain fell largely in the day time with but few bright sunny periods to dry things up.

An interesting point was, that while in the Jorhat, Sibsagar, Nazira, and Sonari districts the disease was caused by the common *Corticium invisium* on the North Bank and in Sylhet, the less common species *Corticium theae* was responsible.

Control measures for either species are described in Tea Encyclopaedia Ser. 8 under 1. 4.

In the Jorhat and Sonari districts Black Rot *(C. invisium)* was also found attacking green crops in the following order of severity. Arhar *(Cajanus indicus)* Bogamedeloa *(Tephrosia candida)* and Giant Hemp *(Crotalaria anagyroides)*. In every instance it was noticed that the attack was worst where the green crop was densely sown.

* Published as Memorandum No. 21

Instance were observed of the transmission of the disease from the green crop to tea either by direct contact, or by means of affected leaves of the green crop falling on to the below.

The danger can be minimised by snowing green crops fairly thinly or by thinning out in July August. Also by removal of alternate lines, where an every line crop has been sown in young tea, when the young tea is pruned and centred at one year old.

Badly affected plants should be cut down and allowed to decompose on the soil, but care should be taken to avoid direct contact between the cut down plants and the tea.

b. Root Diseases.

Many instances of both Brown Root Rot *(Fomes lamoensis)* and Charcoal Stump Rot *(Ustulina zonata)* have been seen in all districts. In almost every instance it has been possible to trace the source of infection to a dead shade tree stump or dead tea bush stump in the vicinity.

Both root rots spread by contact from root to root and do not travel through the soil. The only effective treatment is to uproot and burn the affected bush or bushes and those in immediate contact with them, and to paint the cut surfaces of the roots of neighbouring bushes with strong lime sulphur solution. The area from which the bushes have been removed should be deep hoed and all dead stumps, dead roots etc carefully removed and burnt. Rehabilitate the area by sowing with Boga medeloa or *Crotalaria* and infill in November next year in the usual way.

Where many deaths have occurred in a small area, it is advisable to isolate the area by enclosing it with a 1' wide 3' deep trench. Measures to eradicate the disease as already described can then be taken within the isolated area, at leisure.

10. Green crops.

It was observed that throughout the Jorhat and Sibsagar districts there is a great shortage of Boga medeloa seed, this is due to the attack of the small black weevil *Apion sp.* on the young developing flower buds. Spraying of the Boga medeloa as the flower buds appear with D. D. T. at 1 lb. in 50 gallons water (1 part in 500) was effective in controlling the beetles and those gardens who sprayed early enough, are obtaining seed.

Giant Hemp is at present not attacked by *Apion sp.*, but there is every reason to believe that once it is used on the same scale as Boga medeloa it will sooner or later be attacked by pests.

It is recommended that this danger be minimised by the avoidance of pure stands of one species, and that green crops be grown either in rotation or on an interplanting system.

In the case of Boga medeloa ; if *Apion* attack continues to be serious, it may be necessary for gardens to safeguard their supplies of seed by sowing

a proportion of seed each year in multiplication baries either in tea, or better in waste land, and spraying the plants at intervals during the period of development of the flower buds.

11. Shade Trees.

(a) Albizzia molucanna.

A number of instances have been observed of the adverse effect of *Albizzia molucanna* shade on tea :

A molucanna grows with extreme rapidity, and for the rapid production of *temporary* shade, particularly for young tea, it is extremely valuable. If left to grow for long however, 5-6 years or so, the shade cast is too dense and the roots which lie close to the surface compete with the tea, for food supply and moisture, and as result tea shaded by well grown *A. molucanna* suffers. In addition due to its surface rooting *A. molucanna* is very liable to be blown down in gales, causing considerable havoc.

Gardens in which over heavy *A. molucanna* shade exists, can increase crop and minimise the danger from storms by lopping branches from the trees up to 30 feet or so from the ground.

(b) Mixed Shade.

The importance of using mixed shade cannot be over emphasised, particularly in districts such as Mangaldai where Sau is badly subject to canker.

It is will known that the extensive culture of one particular species over large areas is frequently followed by severe attacks of pests and diseases more or less specific to that plant.

Suggestions as to the use of mixed shade are given in Tea Encyclopaedia Ser. 12 under F. 3.

Sd : P. M. Glover,
Advisory Officer,
Assam Valley and North Bank.

DARJEELING & TERAI.

1. Organisation.

During the year arrangements were made for the purchase of the property known as "The Parsonage" in Kurseong as a Headquarter for the Advisory Officer Darjeeling & Terai.

The property, situated on the Pankhabari Road consists of a Bungalow with outhouses and some seven acres of land under tea, (which latter is leased to a neighbouring Tea Estate). While the Bungalow is under occupation the

question of the transfer of the property was still in the hands of the legal representatives at the end of the year.

The Buildings and compound were in a somewhat dilapidated state, and repairs, additions and alterations were put in hand as soon as the Bungalow was taken over by E. Hainsworth who was on tour in the Darjeeling District from May to July. Work had not been completed by the end of the year.

2. Staff.

The staff consisted at the time of opening up of :—

1 Clerk
1 Field Assistant
1 Mali
1 Chowkidar Mali
1 Chowkidar.

The Field Assistant is untrained and at the end of the year arrangements had been made for him to proceed to Tocklai for 3 months training.

3. Touring.

The Advisory Officer took up his duties in Kurseong at the beginning of September after a period of training at Tocklai and until the end of the year was mainly occupied in organising the office and visiting Gardens with the object of obtaining an over-all picture of prevailing conditions, and studying the particular problems of the area.

The Physical Chemist, Tocklai, toured in September—October with the Advisory Officer in both the Darjeeling and Terai Districts, with the primary object of making a preliminary study of soil conditions and soil erosion problems.

4. Experimentation.

Samples of tea manufactured in October from the Maharanee Manuring Experiments were tasted. It would appear therefrom that the overall value of teas and flavour from plots manured with high levels of Nitrogen (120 lbs. in one case) are not below that of unmanured plots.

Thanks to the co-operation of the Managers of Singell, Ging and Bannockburn Tea Estates, preliminary work on vegetative propagation by the method of leaf cutting was commenced. Bushes had been selected allowed to run up and cuttings were taken from 14 bushes and put out in prepared beds in the compound of the Bungalow, Cuttings in the case of Singell T. E. were put out at the beginning of October, those from Bannockburn toward the end of October. By the end of the year no signs of any callus or initial root formation was evident, though in the main leaves were still green.

It should be pointed out that the area in which the nursery beds were formed is on a Northern aspect at some 4300' elevation and conditions are thus different to those obtaining in the Plains. From observations of work done on Estates elsewhere the indications are that it may be better in the higher

elevations to put down cuttings earlier than is advocated for the Plains in the end of season period. Experiments will be continued in this connection at different elevations and different periods.

With reference to future experimentation the following subjects appear to be most important :—

(1) Pruning methods.
(2) Plucking methods.
(3) Effect of high levels of N. manuring on flavour and quality.
(4) Soil erosion control.

5. Pests & Diseases.

At the back end of the season considerable evidence of *Exobasidium vexans* and *Helopeltis* damage was observed in both the Terai and the Darjeeling areas and the overall loss in crop must have been considerable.

These two pests, together with *Tetranychus biloculatus* in certain areas, and to a lesser extent Scale in the higher elevations are the main pests to contend with.

In certain areas *Rosellinia arcuata*, *Aglaospora aculeata* and Thread Blight are causing considerable loss.

AGRICULTURAL AND BOTANICAL.

1. Staff.

The Agriculturist was in charge of the Botanical Branch from 27th May 1948 to 24th September 1948, during which period the Botanist was on home leave.

2. Touring.

The Agriculturist visited 11 gardens in the Doom Dooma district in addition to visiting various gardens within a radius of 50 miles from Tocklai.

3. Lectures, Reports and Publications.

The Agriculturist gave a course of lectures with practical demonstrations on Vegetative Propagation to a group of planters from Messrs. Mcleod & Co. in September ; and two further lectures on the same subject during the Vegetative Propagation course in October.

Six lectures on Manuring, Shade and Cultivation were given during the General Lecture Courses held from the 22nd. November 1948 to 11th December 1948.

Serial No. 30 of Tea Encyclopaedia was published and Serials Nos. 40 and 43 of Tea Encyclopaedia were published jointly with the Advisory Officer, Assam.

4. Field Experiments.

(1) Late application of G. S. A. Mixture containing 12½% Nitrogen :—

During 1948, many gardens received their manure allocations very late in the season *i. e.* in August and September and enquired of us whether it was of any use applying the manure at that late date or whether to store it until the following season.

It is known that manuring as late as the middle of June gives the same total crop as manuring in March and that manuring in August and September is too late to get the full benefit of the manure in the year of application.

There are however two other important factors to be considered before leaving the tea unmanured for a year on account of receiving the manure late in the season.

(a) The loss in crop in the current season.
(b) Loss of Nitrogen in the manure because of storage for undue length of time.

Bearing the above two factors in mind, an experiment was started to estimate the effect of manuring in August and in September.

80 lbs. of Nitrogen were applied in the form of G. S. A. mixture containing 12½% nitrogen and it was found that when the manure was applied on 1st of August, the crop began to increase from two weeks after application and when applied on 1st of September, the crop began to increase after two weeks, but this increase was not of the same magnitude as when them anure was applied in August. It can therefore be said that application of manure as late as in August, is worthwhile and does give an increase in crop in the year of application. But if the manure is not applied till the 1st week of September, no significant increase in crop is obtained in the year of application.

Maunds of made tea per acre.

Treatments :—

(a)	No manure	...	8·62
(b)	80 lbs. N. on 1st August	...	9·36
(c)	80 lbs. N. on 1st September	...	9·02

Significant difference required :—0·65 mds.

Storage is always risky and unless one is sure of the keeping quality of the manure, the safest thing to do will be to apply the manure as soon as it is received as the bushes will make some response in the following season.

If in spite of all this, one does not wish to apply the manure when received after middle of August, one must make sure of the keeping quality of the manure and must provide good and well ventilated storage accomodation. When one year's manure is stored in this way till the following February, the indent for the following year may be reduced to such a quantity as would

be sufficient to make up to the optimum quantities of manure in combination with the quantities in storage, for the various sections of the garden (as per Tea Encyclopaedia Serial No. 47).

(2) Severity of Plucking and its effect on the frame : Area 20.

Area 20 was planted $4\frac{1}{2}' \times 4\frac{1}{2}'$ triangular in 1924. This experiment was started in 1935 and the treatments have been as follows :—

1.	4″ to Janam.
2.	6″ to Janam.
3.	8″ to Janam.
4.	4″ to Janam, then 1 leaf in Second flush, then to Janam.
5.	6″ to Janam, then 1 leaf in Second flush, then to Janam,
6.	8″ to Janam, then 1 leaf in Second flush, then to Janam.
7.	6″ to Janam till end July then one leaf left.

This tea was medium pruned in end of 1948 to 26″ above ground.

In 1948 the number of branches per bush were counted and the thickness of the branches were measured, at one inch below the pruning height, in order to study the effect of plucking on the frame.

	Treatment.	Mean diameter of branches.	Mean No. of branches per bush.
1.	4″ to Janam.	·504	36·5
2.	6″ to Janam.	·585	29·806
3.	8″ to Janam.	·615	27·0
4.	4″ to Janam and 1 leaf in Second flush.	·564	32·1
5.	6″ to Janam and 1 leaf in Second flush.	·626	28·1
6.	8″ to Janam and 1 leaf in Second flush.	·668	25·7
7.	6″ to Janam till end July and 1 leaf then to Janam.	·590	31·0
	Significant difference	·049	3·7

From the above table it will be observed that the effect of plucking treatment on the diameter of branches and on the number of branches varies inversely, in that the thicker the branches the lesser the number of branches.

The higher is the plucking level the greater is the thickness and the lesser is the number of branches in the frame of the bush.

Leaving a leaf is tantamount to increasing the plucking height : leaving a leaf increases the thickness and diminishes the number of branches.

Treatment 7, which may be regarded as intermediate between treatments 1 to 3 and 4 to 6, appears to have had an intermediate effect on the thickness of branch, though neither the thickness of the branches nor the number of branches associated with treatment 7 can be regarded as significantly different from the effects of the other two treatments at the same tipping level (Nos. 2 & 5).

Pluckig at 8″ to the *janum*, according to our experience, gives the best long term crop yield with *assamica* types of tea.

(3) Effect of Phosphate under Shade : Areas 5 and 40.

Area 5 was planted 4 ft. × 4 ft. square in 1932 and Albizzia stipulata trees were planted in 1942 at 48 ft. × 32 ft. i. e. in the middle of the shade plots containing 96 bushes.

There are 128 plots in this area and half the number of these have no shade trees. 64 plots receive phosphate @ 45 lbs. per acre and 64 receive no phosphates. 64 of these receive Potash @ 45 lbs. per acre and 64 plots do not receive any Potash, 32 plots receive no nitrogen, 32 plots receive nitrogen @ 30 lbs. per acre, 32 receive @ 60 lbs. per acre and 32 receive @ 90 lbs. per acre.

The following table shows the crop yield figures in maunds made tea per acre for the last three years :—

	1946		1947		1948	
	No phosphate	45 lbs $P_2 0_5$	−P	+P	−P	+P
No shade	11·18	10·51	13·07	12·17	14·31	13·74
Shade	11·00	11·52	12·83	13·32	14·43	15·24
Increase due to phosphate under shade.	0·52		0·49		0·81	

Area 40 was planted $4\frac{1}{2}$ ft. × $4\frac{1}{2}$ ft. triangular in 1922 and in 1931 an experiment was started in this area to measure the effect of four levels of phoshoric acid and four levels of Potash supplied to singly and in combination. In 1941 Albizzia stipulata trees were planted in alternate blocks to study the effect of manure with and without shade.

The following table shows the yield figures in maunds made tea per acre for 1948 :—

	No phosphoric acid.	15 lbs. $P_2 0_5$	30 lbs. $P_2 0_5$	60 lbs. $P_2 0_5$
No shade	13·74	14·26	14·15	13·52
Shade	15·54	17·09	16·46	15·74

The significant difference required is 079 mds. From the above figures it is obvious that a small quantity of 15 lbs. of Phosphoric acid per acre, when applied to tea that is under shade, can increas the crop yield by over $1\frac{1}{2}$ maunds of made tea per acre. Higher doses of this manure do not give increase, but may actually reduce crop yield.

The increase in crop yield in Area 5, has not been as high as in Area 40, most likely because of applying a rather heavy dose of Phosphoric acid i. e. 45 lbs. per acre.

Potash has not shown any increase in the crop yield of mature tea.

V. Vegetative Propagation :

(1) A pamphlet on the selection of Vegetative clones was prepared for circulation to Agency Houses.

(2) It has been established that it is beneficial to expose cuttings to full sunlight after they have rooted and before they begin to shoot. Cuttings which are not rooted will be killed by exposure to full light but the percentage of good plants amongst the survivors will be increased. It is necessary therefore to be certain that a good number of the cuttings are rooted before the light intensity ts raised. If this is done then, although raising the light intensity may result in the loss of some non-rooted cuttings, the overall effect will be an increase in the number of acceptable plants. Using the lath-frame method of propagation and taking cuttings at the standard times of April-may and September-October the frames should be permanently raised on the eastern side only so as to expose the cuttings to morning sun as follows :

For April-May propagation :
Raise the frames February 15th.

For September-October propagation :
Raise the frames August 1st.

These times are approximate only and are dependent upon a sufficient number of cuttings having formed roots. On the other hand the frames should be raised before the cuttings have begun to shoot. If the cuttings are allowed to shoot in the shade then they will become sun-scorched when the covers are raised. The covers should be finally and completely removed in the one case about March 15th and in the other case about September 1st so as to allow the shoots to develop in full sunlight. The preliminary and partial raising of the frame for one month, by means of a stick about three feet long, on the east only, is to harden off the old cutting leaf—not the young shoot—before the frame is completely removed.

VI. Breeding :

This is a long term project and reports are made biennially Full details of the progress of the various breeding schemes, and their degree of completion will be found in Appendix "B" to the Botanical Annual Report for 1947.

W. Wight.
Botanist.

S. K. Dutta.
Agriculturist.

BIOCHEMISTRY AND TEA MANUFACTURE.

Considerable time has had to be given to problems of organisation and re-equipment, following a lapse of more than six years in the work of this department. Delays, or failures, in obtaining essential chemicals, apparatus and factory equipment have seriously affected the programme, and the work carried out has been determined largely by equipment available, rather than by its relative importance.

The results and conclusions of the past years work are summarised below. Detailed accounts will be found in Quarterly Reports, Appendices to the above, and in various technical communications now in preparation for the Biochemical Journal.

1. Mechanism of Fermentation.

(1) Nature of the Tea Oxidase.

In 1941 it was concluded, on the basis of the evidence then available, that the oxidase responsible for tea-fermentation was most probably cytochrome oxidase. This view was contested by Ceylon workers, who claimed that no trace of a cytochrome system in tea-leaf could be determined spectroscopically, and who further demonstrated the existence of a copper-protein oxidase in tea. As is to be reported elsewhere, the conclusons drawn by Ceylon could not be accepted in their entirety, but further work on this subject has now led us also to conclude that the tea-leaf contains no cytochrome oxidase. The tea-oxidase is in fact a copper-protein, with properties intermediate between those of cytochrome oxidase and the copper-protein in mushroom polyphenol oxidase.

This result is not only of academic interest for it establishes the essential nature of copper for the tea-leaf, and for fermentation, a finding which may have considerable importance when the importance of trace elements in tea is further investigated.

(2) Localisation of the Tea Oxidase.

In 1940 evidence was found and published for the localisation of oxidase activity in the chloroplasts.

Recently Li and Bonner, working in America, have also come to the same conclusion. Their results show that chloroplast fractions from tea-leaf possess considerable oxidase activity, although it by no means follows from their figures that oxidase activity is concentrated in the chloroplasts. Our own results have extended both our own original findings and those of Li and Bonner, and although confirmatory work is still needed, it appears reasonably definite that the greater part of the tea-oxidase is localised in the chloroplasts (and possibly other plastids), although some oxidase remains in the clear solution left after centrifuging down the chloroplasts from expressed tea-juice.

As the catechins, as we now prefer to call the tea-tannis, have been shown to be localised in the vacuole, it follows that oxidase and catechins,

which must come into contact before fermentation can start, are quite widely separated from each other in the individual cell. It is possible to initiate fermentation either by rupturing the fragile membrane which separates the vacuole contents, and hence the catechins, from the rest of the cell, or by a complete breaking up of the cell.

In order to rupture the vacuolar membrane it does not seem necessary to break the outer cell-wall. A twisting of the leaf, such as is imparted in the rolling process, appears to be sufficient to break this membrane without affecting the outer cell-wall appreciably. An adequate wither helps this twisting process, which can theoretically be carried to completion without breaking the shoot. If pieces of the shoot are broken off during rolling they will acquire a twist less easily. The importance of the appearance of manufactured tea is therefore confirmed. Tea which is well twisted and not broken up has received the necessary treatment to ensure a good fermentation.

There are two other ways in which the permeability of the vacuolar membrane can be broken down and a fermentation started; by heating to 120-130°F., and by exposure to chloroform vapour. In each case the intact leaf reddens, due to a mingling of oxidase and catechins.

It is not necessary to wither leaf and give it the conventional roll in order to obtain a good fermentation. So long as the tissues are adequately smashed up the catechins can come into contact with the oxidase and fermentation will proceed. In order, however, to obtain a full fermentation it is necessary to break the tissue up very considerably, and in consequence, the bulk of the tea produced will be of the fannings and dust type.

The observed differences between the old conventional type of manufacture and the kutcha type, are just what would be expected from the localisation of oxidase and catechins in the chloroplast and vacuole respectively.

The water-soluble oxidase is also of some practical interest. According to our present estimates (which may however have to be revised) some 30% of the oxidase in the stem is water-soluble but only about 6% of the oxidase in the blade is water soluble. This water-soluble fraction will be found in the tea-juice expressed in rolling, and is presumably in part responsible for the oxidation which occurs on the surface of the leaf. It is emphasised however that the greater part of the oxidase is in an insoluble form and remains behind in the leaf when juice is expressed. Undue expression of juice therefore effects a partial separation of catechins away from the oxidase. It is therefore preferable to roll leaf with the minimum elimination of juice so that the catechins remain in intimate contact with the insoluble oxidase.

(3) Oxidase Assay and Diffusion Effects.

The rate of fermentation depends, amongst other factors, on the amount of oxidase in the leaf. It is possible to estimate the amount of oxidase by measuring the rate at which oxygen is taken up by fermenting leaf in the Warburg apparatus under certain standardised conditions. It is important to

specify the actual amount of leaf used as it has been found that the rate does not increase in a linear manner with the amount of tissue but that the greater the amount of tissue taken the slower becomes the rate per unit amount of tissue.

Thus with 50 mg. tissue the average rate of oxygen uptake is 384 c. mm. per hour whereas with 400 mg. the rate instead of being 3072 c. mm. / hr as would be expected, is only 1020 c. mm. / hr.

It now appears that this effect is due to diffusion effects within the damaged tissue. Even after the leaf has been twisted so that the contents of the vacuole can penetrate into the rest of the cell, the catechins have still to diffuse through the protoplasm to reach the chloroplasts. Oxygen also has to diffuse into the tissue from outside.

Other facts also indicate that diffusion of oxygen and catechins in the rolled leaf may control the rate of fermentation.

(1) Fermentation in oxygen is very much quicker than in air.

(2) Leaf which has received more extensive damage. e. g. as in a C. T. C., ferments faster.

(3) Withering, although it results in partial inactivation of oxidase, may result in a slightly faster fermentation, due, presumably, to the established increased permeability of the tissues which follows withering. At high withers enzyme inactivation becomes too great to compensate for the increased permeability, and fermentation becomes slower.

The following factors therefore determine the rate of fermentation.

(1) The oxidase activity.

(2) The concentration of oxygen.

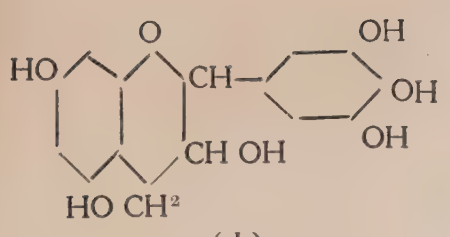
(3) The wither, and its effect on the permeability of the tissue.

(4) The extent of smashing up of the tissue which has occurred in rolling.

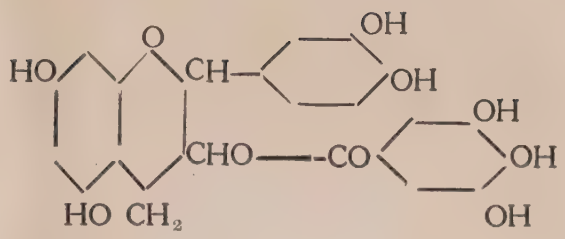
(4) Origin of CO_2 in Fermentation.

During fermentation not only is oxygen consumed but a certain amount of carbon dioxide (CO_2) is given off. Previous work at Tocklai led to the conclusion that this CO_2 was mainly produced as a result of carbohydrate oxidation by the oxidation products of the catechins, and it was also thought that amino-acids and fats might possibly be oxidised in a similar manner. Ceylon, on the other hand, have claimed that no CO_2 is produced in fermentation, and that any CO_2 evolved must come from intact leaf respiring in a normal manner.

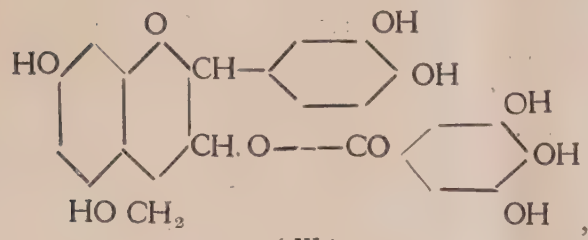
Previous work of this department makes it definite that there is very little intact normally respiring leaf after rolling, and it has been proved that normal respiration makes little contribution to the CO_2 evolved in fermentation. On the other hand it has now been found, that under certain conditions, those of the tea-catechins which have a pyrogallol-like structure, i. e. (I), (II) and (III) but not (IV), may yield CO_2 as a result of oxidation.



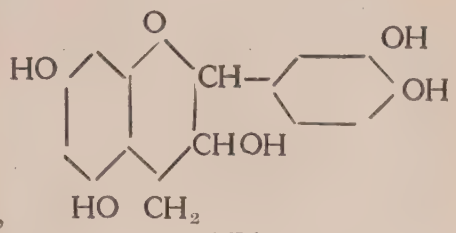
(I)



(II)

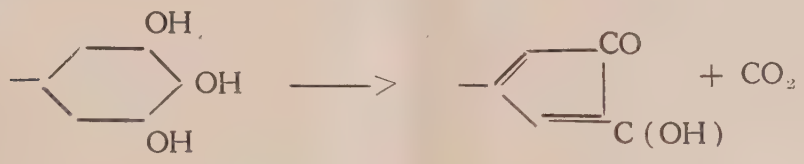


(III)



(IV)

Under laboratory conditions there is a partial breakdown of the above molecules, possibly of the type



whiich meana that each of the pyrogallol catechins may give two series of oxidation products. How far this partial breakdown takes place in fermentation under factory conditions is not yet known.

CO_2 evolved during fermentation may therefore originate in several different waya and further study of its production under factory conditions seems called for.

It has been established that oxidation of amino-acids as a result of fermentation is unlikely.

II. CHEMICAL COMPOSITION OF TEA-LEAF.

(1) Lipides.

A new method has been worked out for estimating the lipides (fats) in tea-leaf. The lipide-content is much higher than was previously suspected (8-10% of the total dry matter of the leaf). It has been established that the total amount of lipide is not appreciably affected by fermentation but it has yet to be shown whether there is any definite chemical change in the lipides as a rasult of fermentation.

(2) Catechins.

Extensive studies have been made of the catechins in tea-leaf, by the method of filter paper partition chromatography. This extends the work done by Bradfielp

at home. The results so far indicate that although there may be as many as eight individual catechins in tea, the relative proportions of these different substances in different types of tea vary very little. At present therefore there is little evidence to show that differences in quality are due to differences either in individual or total catechins.

(3) Amino-acids.

It has been established that the main components of this important group of substances in the tea-leaf are aspartic and glutamic acids and a peptide of glutamic acid . Other amino-acids, of which alanine is one, occur in smaller quanties.

Addition of glutamic acid to an infusion of tea resulted in a notably poorer liquor according to our tea-taster, although such addition did not result in any foreign flavour. The indications are that glutamic acid may be an undesirable component of tea, as far as quality is concerned.

As with the catechins, paper chromatography has been used extensively to study the amino-acids, and it appears that the relative abundance of these substances varies little from one type to another. It has also been shown that fermentation has little if any effect on the amino-acids.

Preliminary work has shown that the water-soluble nitrogen (amino-acids + caffeine) is very variable and some link with quality may be found here. The difficulty is, that as yet, no really reliable method of estimating amino-acids in the presence of catechins has been found, nor has it been found possible to obtain amino-acids free from catechins.

III. MANUFACTURE.

(1) Experiments relating Quality to Chemical Composition.

The following material is under study and is being analysed chemically. Miniature manufactures have been carried out with a view to correlating taster's findings with chemical composition.

(1) A and AN agrotypes. This material gave teas very high in strength but coarse and poor in quality. Average valuation Re. 1/ 13/ 8.

(2) N agrotypes. This was nearly as good as the above for strength, and had good quality. Average valuation Rs. 2/1/0.

(3) Miscellaneous bushes all showing some *China* characters. The taster always commented on China character. Average valuation Re. 1/14/6.

(4) Raised from seed from Indo-China. This tea was much inferior to the others and had low marks for all liquor characters. Average valuation Re. 1/10/2.

Differences in liquor characters are satisfactory and the material should be of value in attempting to correlate chemical composition with liquor characters.

(2) Rolling Experiments.

As a preliminary to more extensive investigations into rolling, samples were taken of the first fine mal, and estimations made of the progress of fermentation after 3 hours. In the particular samples taken it was found that the extent of fermentation was satisfactory (86—91% complete). The possibility that the first fine mal might contain an appreciable proportion of undamaged, and therefore unfermented, leaf was therefore excluded.

IV. ADVISORY WORK.

40 memoranda on subjects relating to manufacture were issued during the year, scarcely half of which were in answer to specific enquiries from gardens.

Touring was mainly restricted to local gardens but a more extended tour was carried out in the Mangaldai district.

E. A. Houghton Roberts
D. J. Wood.
Biochemists.

ANALYTICAL BRANCH.

I. Sub-soil Conditions :

Considerable attention has been paid during the year to investigation of sub-soil conditions. There are many instances where tea does not do well or where it is difficult to establish tea inspite of a satisfactory chemical status of the soil. Drainage condition, inadequate aeration of the soil, compacting etc, are all possible causes which may, either alone or jointly, account for the poor results. The importance of correct air and water relationship in the soil has been stressed.

II. Trace Elements :

The possibility of mineral deficiencies in the soil acting as limiting factors has long been realised. There are many instances where we have reason to believe the tea shows trace element deficiency symptoms. A rough field trial, jointly with the Pathology Branch, has been started on a certain garden in the valley. Further work is necessary before definite results can be quoted.

III. Touring.

A large number of gardens have been visited in the Assam Valley specially those in Nazira, Golaghat and Nowgong districts. The tea districts of Terai and Darjeeling were also visited during October/November with special reference to soil problems of hill areas.

IV. Publications :

4 serials have been issued for the encyclopaedia.

V. Analytical and Advisory work :

(a) Analytical : Large numbers of samples continue to be received from gardens for analysis and report. The actual number analysed during the year was.

Soil samples	...	405
Manure samples	...	36
Water samples	...	22
Others ...	...	28

(b) Advisory : In reply to queries from gardens 164 advisory reports were issued. In addition visits have been paid to gardens where necessary.

N. G. Gokhale.
Physical Chemist.

PLANT PATHOLOGICAL BRANCH.

For the last two years the work of the Pathological Branch has been following a closely-planned pattern, and it is as well to explain briefly at the outset of the report what this pattern of work is.

Developments of all classes of plant protection materials made rapid strides between 1937 and 1947. Many new materials were brought on to the market, and their efficiency in the control of pests and diseases on other crops was known. It has been our immediate duty to the Tea Industry, therefore, to find out without delay what effect these new materials have on tea pests and diseases. Some of this work is now completed and is summarised later in this report. Almost all of the major field trials, which have followed on our laboratory tests, are still in progress, and are expected to mature before the end of 1949. It can be said, however, that the current work is in line with contemporary trends, and that the branch is now almost up to date.

One of the aspects of our work which will appeal to the Industry, is that, in all our trials we have dealt only with the quantal, or all-or-nothing response. In other words, a pest or disease is either killed or not killed by a treatment, and measures against pests and diseases which are only partially effective in the field are automatically discarded. For all pests and diseases we have standard treatments, which are recommended whenever called for. Some of these treatments were evolved many years ago and are in need of reinvestigation, in the light of our declared policy of looking only for a quantal response in treatments. Our policy in deciding the order in which to investigate

the control of pests and diseases is to take them in their order of importance, and to work on them one by one until success is achieved. It will thus be clear that, under this system, work on such problems as Black rot and Red spider receives a high priority, and that it has more than once been necessary to resist pressure to undertake large-scale work on a particular pest or disease which, although possibly slightly important to an individual garden, is of a relatively minor nature to the Industry as a whole.

Two important sidelines to this work became apparent early on. Firstly, it was found that spraying equipment as was and is being supplied to the Industry is obsolete. It became necessary, therefore, to assemble a representative collection of sprayers and nozzles in Tocklai, with a view to conducting comparative tests. These tests are at present in progress and our recommendations as to the types of equipment best suited to present growing conditions will appear in 1949. Secondly, it was apparent that the accepted times for dusting and spraying to control pests and diseases, would bear reinvestigation. Changed labour conditions made it clear that it was no longer practicable to spray tea at the height of the plucking season, and that it would be well if successful methods for spraying tea after pruning, during the cold weather, could be devised. No success has been achieved so far in this work, which is none the less proceeding on the highest priority.

There follows a brief account of the work carried out in the Branch during the year.

1. The use of DDT in the control of pests.

Following work on *Helopeltis* control in 1947, DDT was successfully used to control the following insect pests :–

Looper caterpillar	(*Biston suppressaria*)
Mound-Building Termite	(*Odotermes Sp.*)
Cricket	(*Brachytrypes achatinus*)
Nettle grubs.	(Various spp.)
Medeloa beetle	(*Apion* sp.)
Thrips.	(*Physothrips setiventris and Haplothrips tenuipennis*)

In all cases the most convenient, efficient and inexpensive type of DDT has been found to be the 50% Wettable powder with added sticking agents, which ensure that the DDT is not washed off by rain after application. In some cases firms have now prepared "Agricultural" powders of this type to our own specification. With such powders, control of the above pests is possible using spray fluids containing 1 lb of powder in from 40 to 50 gallons of water. For further delails of control of these pests, see the publication "looper caterpillar" or the relevant sections of the Tea Encyclopaedia.

It is necessary to repeat that DDT is not effective against Red spider. We have also found it to be of no value in the control of the Tea Seed Bug *(Paeciliocoris latus)*.

2. The use of Benzene Hexachloride (Gammexane) as a control against insects pests on plucking tea causes a taint which persists into the subsequent made tea. The manufacturers have produced a non-tainting formulation which we have recently received and which will be tested in 1949. In the meantime there is no objection to the use of this substance in the control of moundbuilding termites and crickets.

3. Shade tree cankers :—

These are caused by the attack of two insects, *Agrilus beesoni* and *Cryptorrhyncus* Sp., which lay eggs in the bark, and the damage caused by the developing larvae is followed by bacterial and fungal attack which spreads from the damaged tissue. Simple control measures have been devised and published in the Tea Encyclopaedia.

4. Red spider :—

Large scale field trials on Mijicajan Tea Estate in the Darrang district, were carried out in the early months of the year, following on laboratory tests. Red spider developed in the trial areas much too late for the effects of any of the treatments to be still apparent, and the analysis of the experimental figures failed to produce any significant results. However it was quite clear that the effects of defoliation, (that is, removing all old leaves from the bush at the time of clearing out) far outweighed any of the chemical treatments in effectively delaying the advent of the pest. Whilst such a treatment did not guarantee immunity, colonisation of defoliated tea plants by Red spiders was always from neighbouring bushes which were still in possession of their old leaves. The department is indebted to Mr. H. C. Andrews of Mijicajan T. E, for his co-operation in these experiments.

As the quiescent stages and the eggs of Red spider are not affected by most of the acaricides which we have tested, one spraying round followed by a second spraying when all the eggs have hatched, has always been considered essential to achieve full control. To find out the exact interval between the first and second sprays, monthly observations were made on the incubation period of the eggs throughout the year. This period varies with the temperature and Relative humidity. If the temperature is high, it is shortened to 4 days and if the temperature is low, it is prolonged to 13 days, under Tocklai conditions.

	Date of egg-laying	Incubation period		Field Temperature & Humidity.			
		Uuder lab. conditions.	Under field conditions.	Average Max.	Aveage Min.	Mean Avg. Temp.	Average Humidity %.
January	16th	12	13	71·3	50·3	60·8	100
February	2nd	10	11	70·5	50 5	60·5	100
March	2nd	7	8	82·3	55·8	69.5	98·5
April	5th	5	6	86·1	65·5	75·8	89·2
May	3rd	4	5	84·8	70·1	77·4	88·4
June	16th	$3\frac{1}{2}$	4	85·9	74·0	79·9	95·3
July	5th	4	$4\frac{1}{2}$	89·3	75·9	82·6	94·4
August	9th	4	5	87·3	75·3	81·3	93·0
September	14th	4	5	89·4	76·2	82·8	91·4
October	15th	5	6	86·9	69·3	78·1	93·2
November	2nd	7	8	82·6	64·1	73·3	95·3
December	6th	11	12	73·9	48·0	60·9	95·2

5. *Sclerotinia* :—

A new and importnat disease of tea flowers and fruits was discovered in March 1948. I first observed the disease in the Badulipar Company's seed bari in the Golaghat district on young dead fruits, and it has subsequently been found to be present, both on young fruits and flowers, in the following seed baries.

Tocklai	...	Sibsagar district.
Cinnamara	...	" "
Tippuk	...	Doom Dooma district.
Gaipani	...	" "
Doomur Dullong	...	Moran district.
Sepon	...	" "
Dekhari	...	" "
Thowra	...	" "

In no instance has material from any seed bari been found to be free from the disease.

The Life-history of the disease has been worked out and is as follows.

From October to December during the flowering season, the petals of the flowers become covered with mould and turn brown. They wither on the stalk and remain attached to the plant for some time. Unaffected petals drop off whilst still fresh in appearance. In the calyx of the flower this mould gives rise to a resting Sclerotium, which is black, thick-skinned, flat, and oval in shape, being about 1/10" long. Most of the affected flowers remain sterile, and the calyx later turns brown and drops off. Some of the affected flowers may have set their seed, but in these instances the developing fruit turns black and drops off the tree when about the size of a pea, between March and June of the following year.

The Sclerotium remains unchanged until the next time of flowering, in October and November. At this time a small mushroom-like body or apothecium

arises from the Sclerotium, which is lying on the ground under the seed tree, and produces a few small ascospores which are discharged into the air. These spores, when falling on to flower petals, can again infect them and give rise to the mould-like growth.

The disease, which is evidently extremely common, is a member of the *Sclerotiniaceae*, and appears to be a new species of thc genus *Botryotinia* For the time being I have called it the *Sclerotinia* disease of the tea flowers.

Control measures :—

Based on current methods of controlling allied diseases of orchard crops in America and Europe, three experiments in the control of the disease are in progress.

5.1 The most effective fungicide to be used :—In this experiment 12 fungicides are under investigation. These were sprayed on to tea flowers in November and the percentage set of seed subsequent to spraying is being determined.

5.2 The best time of spraying :—Combinations of four spraying times are being investigated on a 7 acre seed bari at Badulipar T. E. For this experiment, lime-sulphur is being used as a standard, but it would be wrong to conclude that lime-sulphur is the best fungicide to use in controlling this disease until the results of the first experiment are available.

5.3 The effect of manurial treatments :— Observations are being made on the effect of manures on the susceptibility of the flowers to the disease, on seed-bari manuring experiments already in progress.

The treatments in these experiments are already applied but the results, expressed in terms of seed yield, will not be apparent until the seed matures in 1949.

6. Blister blight :—

With the primary object of studying this disease I was able to spend some time in Darjeelng this year. Results of spraying experiments in the control of this disease may be briefly summarised as follows.

1. Copper sprays were more effective than sulphur sprays in controling Blister blight.

2. Of the Copper sprays 'Perenox' and 'Copper sandoz' gave the highest degree of control.

3. Spraying, unless repeated at intervals of 7 to 10 days during the epidemic period was not effective.

4. A quantal response (see introduction to this report) was not obtained in this series of experiments.

These results accord closely with results obtained by Tubbs in Ceylon.

Work on Blister blight control is continuing and further reference to this disease is made in the report on my visit to South India and Ceylon included in this Annual Report.

7. Black rot and Thread blight :

A memorandum on Black Rot by Mr. Tunstall, who retired in March 1948, has been published and distributed to members, which deals comprehensively with existing knowledge on the control of this disease. As mentioned in the introduction to this report, the question of control of diseases by winter spraying is being reinvestigated, and included in the programme of work on Black rot and Thread blight.

8. Advisory :—

Dr. Das the Entomologist, and myself visited 62 gardens during the year. Writing advisory memoranda, and the preparation of these, makes heavy demand on our time, a total of over 400 being sent out to gardens during the year. *As this is considered to be the moet important part of our work, we make a special request to all garden managers never to hesitate in writing to Tocklai about their pest and disease control problems.* Particularly is this so in the question of identification of pests and diseases where an unusual or unknown pest or disease is seen, correct diagnosis and prescription can often circumvent severe loss.

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I also have to acknowledge the co-operation of Dr. Das and the efficiency and enthusiasm of my staff, which has made possible the successful execution of such a large programme.

E. Hainsworth.
Plant Pathologist.